

C66-5067

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CONTRACT REQUIREMENTS	CONTRACT ITEM	MODEL	CONTRACT NO.	DATE
Exhibit E, Para. 5.15.1	Line Item 13.0	LEM	NAS 9-1100	12/17/65

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**REPORT**

NO. LSR-490-33 DATE: 1 June 1966

LEM MONTHLY MASS PROPERTY STATUS REPORT (U)

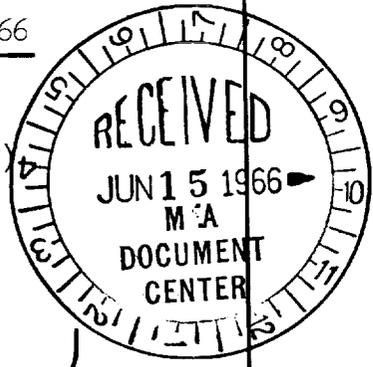
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INTRODUCTION

This report contains the LEM Mass Properties status as of May 19, 1966 for the Lunar Landed Vehicle. The total weight at Separation is 31,305.8 pounds, which is 1.3 pounds lighter than that previously reported in LSR-490-32, dated 1 May 1966.

A summary of changes since the last report is as follows:

A.	Ascent stage inert* weight	-2.4	pounds
B.	Ascent stage propellant	+ .3	pounds
C.	Descent stage inert* weight	+1.5	pounds
D.	Descent stage propellant	- .7	pounds

Total LEM Weight Change at Separation -1.3 pounds

A more detailed breakdown of the changes since the last report is included on page 11. Changes in this report are as follows:

- A. Incorporation of current Government Furnished Equipment.
- B. Additional Super Weight Improvement Program weight savings.
- C. General updating of weight based on current data.

The current listing of Government Furnished Equipment (GFE) in this report and the equipment weights are generally in agreement with reference 5. Exceptions to this are the retention of the LEM/CSM docking receptacle on the Government Furnished Equipment listing, a lower drogue weight, and updating of MIT equipment weight in accordance with reference 17. These deviations were informally discussed and approved by MSC.

The weight impact resulting from Critical Design Review (CDR) Part #1 and Part #2 have been re-evaluated. A detailed status of these changes is presented as Appendix B of this report. A summary of the items still unincorporated appears in the pending changes.

The assumed  $\Delta V$  Budget of 13,918 fps. for the LEM Reference Mission remains unchanged since the last report. The distribution of this budget is Ascent  $\Delta V = 6586$  fps. and Descent  $\Delta V = 7332$  fps.. The reference mission requires more propellant than the critical abort mission, which was defined in the August LEM Mass Property Report, LED-490-23.

\* Inert weight includes all non-propulsion expendables.

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INTRODUCTION - Cont.

The currently reported  $\Delta V$  propellant is based on an ascent  $I_{sp}$  of 304.3 sec. and a descent  $I_{sp}$  of 301.0 sec.. The 304.3 sec., ascent  $I_{sp}$ , is based on a continuous - burn RCS  $I_{sp}$  of 273 sec. and an ascent Propulsion average  $I_{sp}$  of 306.3 sec.. The 301.0 sec., descent  $I_{sp}$ , is based on a descent Propulsion integrated average  $I_{sp}$  of 302.1 sec.. The manufacturer's current integrated average nominal  $I_{sp}$ 's are 310.0 sec. for the ascent engine, and 300.2 sec. for the descent engine. The manufacturer's current continuous burn RCS nominal  $I_{sp}$  is 273 sec..

SCRAPE effort on 1032 pounds of ascent structure indicates a current potential weight saving of 136 pounds. The total ascent scrape weight saving incorporated to date is 130.5 pounds. (125.4 pounds was scraped from Vehicle Design Integration drawings and 5.1 pounds was scraped from Crew Provision drawings.) The 923 pounds of descent structure, reviewed and scraped, previously indicated a potential weight saving of 114 pounds. The 21.4 pounds of saving incorporated in this report brings the total incorporated descent structure weight saving to 125.9 pounds. Actual Scrape effort on the descent structure is more effective than the initial review and estimates indicated.

Other SWIP items incorporated in this report reduce the descent stage 5.4 pounds. A listing of SWIP items incorporated in weight reports to date is included as Appendix A of this report.

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Figure 1  
**LEM ALLOWABLE STAGE WEIGHT APPORTIONMENT**

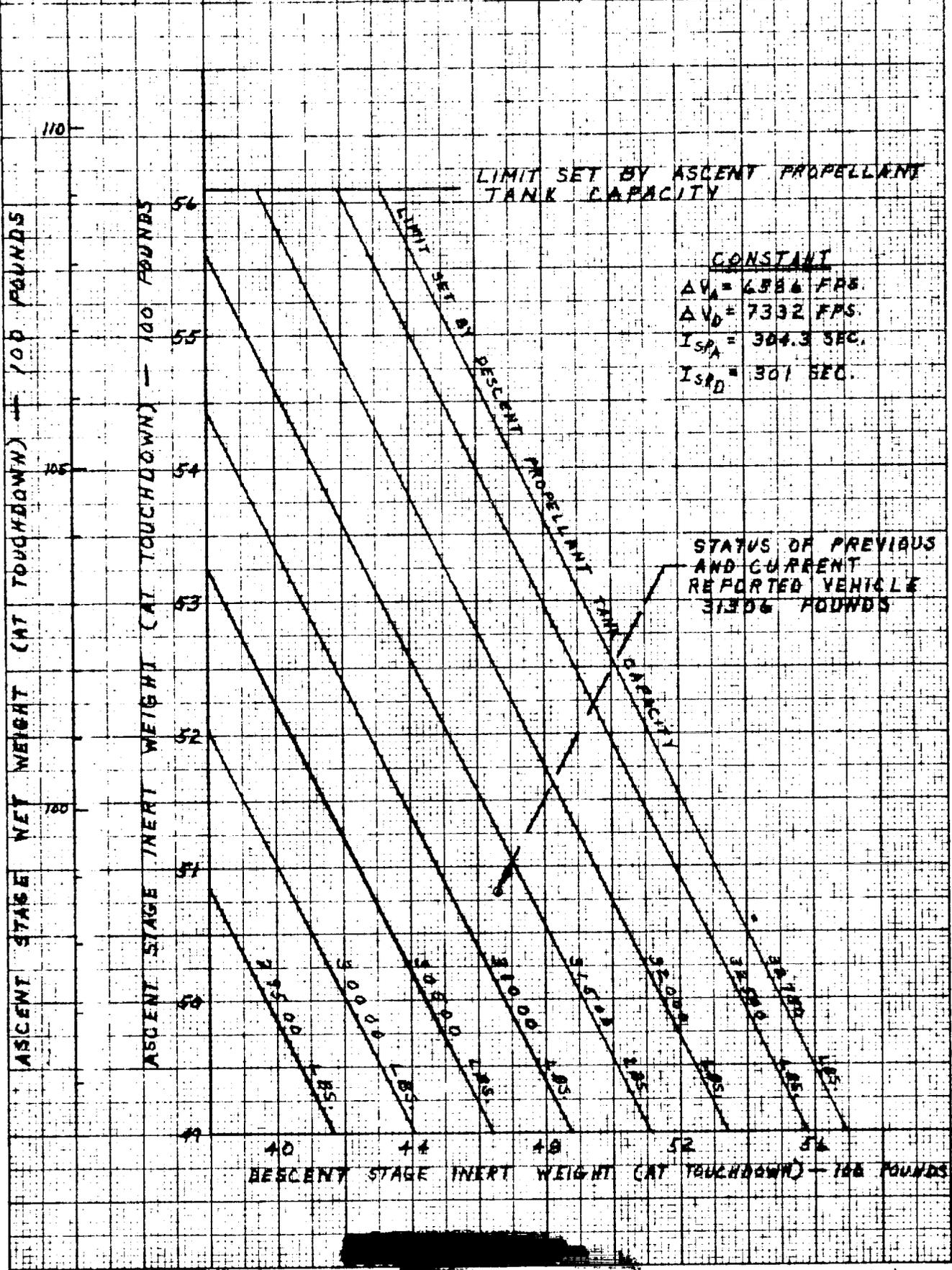


Table 1  
LEM MASS PROPERTY HISTORY

MISSION PHASE	WEIGHT EARTH POUNDS	CENTER OF GRAVITY			MOMENTS OF INERTIA						PRODUCTS OF INERTIA		
		DISTANCE FROM THRUST AXIS			SLUG FT <sup>2</sup>						SLUG FT <sup>2</sup>		
		X	Y	Z	I <sub>xx</sub>	I <sub>yy</sub>	I <sub>zz</sub>	I <sub>yz</sub>	I <sub>xz</sub>	I <sub>xy</sub>	I <sub>xz</sub>	I <sub>yz</sub>	I <sub>xy</sub>
Translunar Injection	30754	182.5	0.7	-0.7	20992	23493	23725	436	198	140			
LEM/CSM Separation	31306	183.8	0.7	0.1	22421	24803	24849	428	531	146			
End Insertion to Hohman - Descent	30900	183.5	0.7	0.1	22165	24580	24657	430	531	147			
Begin Hover	16286	203.9	1.3	0.3	12642	15334	17487	448	494	66			
Lunar Touchdown	14536	212.1	1.5	0.3	11512	12380	14757	451	484	27			
Lunar Launch (lift-off)	9766	242.0	0.2	1.5	6165	3266	5473	4	141	68			
End Insertion to Hohman - Ascent	5204	255.0	0.4	2.8	3035	2711	1856	10	100	62			
Burnout (docked)	4903	255.9	0.4	3.0	2867	2617	1613	17	98	62			
Completion of Crew Transfer	4282	256.0	0.4	-1.6	2581	2356	1482	18	116	57			

**Table 2**  
**SUMMARY OF LEM WEIGHT REPORTING MISSION**

MISSION PHASE	ELAPSED TIME FROM EARTH LAUNCH		REPORTING MISSION (Day Landing) For Loading Expendables		
	Hours	Minutes	Hours	Minutes	
Prelaunch (Launch Vehicle Fueling)	-10	0	10		Pre-Separation Period Dormant Period
Launch	0	0		12	
Earth Parking Orbit		12	2	49	
Translunar Injection	3	1		5	
Translunar Coast- Prior to Transposition	3	6		15	
-During Transposition	3	21		30	
-Subsequent to Transposition	3	51	60	24	
Lunar Orbit- Insertion	64	15		6	
-Coast Prior to Separation	64	21	1	26	
-Checkout	65	47	2	17	
LEM Separation and Insertion to Descent Transfer Orbit	68	4			Descent*
Coast in Descent Transfer Orbit	68	24		20	
Powered Descent (& Hover)	69	22		58	
	69	32		10	
Lunar Staytime	104	17	34	45	Active Period
Powered Ascent	104	17		7	
Parking Orbit Contingency ***					
Coasting Ascent Transfer				47	
Rendezvous	105	11		8	
Docking	105	19		15	
Crew Transfer	105	34		10	
	105	44			
Dormant LEM Time			75	47	
Active LEM Time			39	57	
Post-Separation LEM Time			(37)	(40)	
Total LEM Period			115	44	

\* Descent Period - 1 Hour 28 Minutes

\*\*Ascent Period - 1 Hour 27 Minutes

\*\*\*The Design Reference Mission (DRM) does not appear to have any Parking Orbit Contg..

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GRUMMAN AIRCRAFT ENGINEERING CORPORATION

Table 3

LEM WEIGHT BY STAGES AT EARTH LAUNCH AND LUNAR ORBIT SEPARATION - DISTRIBUTION OF THE INERT WEIGHT BY PERCENTAGE

	WEIGHT			PERCENTAGE			
	ASCENT (1176.4) 1176.4	DESCENT (1273.8) --	TOTAL (2450.2) 1176.4 1273.8	EST'D 33.1 21.4 44.1 34.0	LAYOUT 9.5 8.7 10.2 --	CALC'D 49.6 55.3 44.2 66.0	ACTUAL 7.8 14.6 1.5 --
1.0 Structure							
-Ascent							
-Descent							
2.0 Stabilization and Control	76.6	14.2	90.8	--	.5	--	--
3.0 Navigation and Guidance	71.3	37.8	109.1	45.6	3.4	99.5	--
4.0 Crew Provisions	73.1	--	73.1	4.1	--	51.0	--
5.0 Environmental Control	284.0	107.5	391.5	27.0	--	55.6	40.3
6.0 Landing Gear	--	476.3	476.3	14.1	1.8	71.2	--
7.0 Instrumentation	128.2	5.9	134.1	14.1	14.8	71.1	--
8.0 Electrical Power Supply	741.6	637.5	1379.1	30.5	.4	14.1	55.0
9.0 Propulsion	519.0	1092.5	1611.5	4.0	5.1	49.1	41.8
10.0 Reaction Control	279.8	--	279.8	29.8	1.4	10.1	58.7
11.0 Communications	111.8	17.8	129.6	22.0	--	78.0	--
12.0 Controls and Displays	194.0	--	194.0	24.5	2.9	51.5	21.1
13.0 Explosive Devices	11.5	34.0	45.5	48.1	--	23.3	28.6
Hardware- Sub-Total	3667.3	3697.3	7364.6	23.2	4.9	44.8	27.1
14.0 Government Furnished Equipment	453.3	190.6	643.9	80.2	--	12.7	7.1
15.0 Liquids and Gases - Excludes Propellant	118.3	323.8	442.1	65.7	--	34.3	--
16.0 Propellants - Excludes Delta - V	441.5	473.8	915.3				
Inert- Sub-Total	4680.4	4685.5	9365.9				
16.0 Propellants - Delta - V	(4813.6)	(16574.5)	(21388.1)				
-Propulsion	4537.9	16574.5	21112.4				
-Reaction Control	275.7	--	275.7				
Total - Earth Launch	9494.0	21260.0	30754.0				
5.0 Environmental Control	-1.0	--	-1.0				
14.0 Government Furnished Equipment	+565.5	--	+565.5				
15.0 Liquids and Gases - Excludes Prop.	+6.9	-15.2	-8.3				
16.0 Propellants - Check-out	-4.4	--	-4.4				
Total - Separation	10061.0	21244.8	31305.8				

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Table 4

LEM CURRENT WEIGHT MISSION HISTORY BY STAGES

MISSION PHASE AND CONSUMABLE DESCRIPTION	ASCENT STAGE		DESCENT STAGE		TOTAL WEIGHT (LBS)
	DRY WEIGHT (LBS)	$\Delta V$ -PROPELL. WEIGHT (LBS)	DRY WEIGHT (LBS)	$\Delta V$ -PROPELL. WEIGHT (LBS)	
EARTH LAUNCH AND TRANSLUNAR INJECTION	4680.6	4813.6	4685.3	16574.5	30754.0
ECS-Umbilical Hardware	-1.0				
GFE-Electrical Umbilical	-3.1				
-Crew	+352.0				
-Crew Equipment	+177.4				
-Scientific Equipment	+31.0				
-Television Camera	+8.2				
Liquids and Gases-Oxygen	+6.9		-1.5		
-Water			-13.7		
Propellant - Checkout	-4.4				
SEPARATION	5247.6	4813.6	4670.1	16574.5	31305.8
Liquids and Gases -Oxygen			- .5		
-Water			-9.4		
Propellant -Main $\Delta V$				-16574.5	
-Reaction Control $\Delta V$		-19.7			
-Attitude	-165.6				
LUNAR TOUCHDOWN	5082.0	4793.9	4660.2		14536.1
CFE-Hardware	-9.9		-3697.1		
GFE-Crew Equipment	-94.1		-20.6		
-Scientific Equipment			-170.0		
Liquids and Gases -Oxygen	- .2		-44.5		
-Water	- 1.6		-203.9		
-Helium			-49.7		
-Nitrogen			- .6		
Propellant - Unusable			-473.8		
-Checkout	- 4.4				
LUNAR LIFT-OFF	4971.8	4793.9			9765.7
Liquids and Gases - Oxygen	- .8				
-Water	-11.5				
Propellant -Main $\Delta V$		-4537.9			
-Reaction Control $\Delta V$		-256.0			
-Attitude	-56.6				
BURNOUT (DOCKING)	4902.9				4902.9

LEM WEIGHT STATEMENT							
CODE	ITEM	5/1/66 WEIGHT AT SEPARATION	BURN OUT	CONS'D ON ASCENT	JET. ON LUNAR DESCENT	CURRENT WEIGHT STATUS TOTAL SEPARATION	X-LUNAR EARTH EXPEND- LAUNCH ABLES TOTAL
1.0	Structure	2473.3	1176.4	1273.8		2450.2	2450.2
2.0	Stabilization and Control	92.9	76.6	14.2		90.8	90.8
3.0	Navigation and Guidance	109.1	71.3	37.8		109.1	109.1
4.0	Crew Provisions	73.2	73.1			73.1	73.1
5.0	Environmental Control	391.3	275.4	115.1		390.5	1.0 391.5
6.0	Landing Gear	477.2		476.3		476.3	476.3
7.0	Instrumentation	131.3	128.2	5.9		134.1	134.1
8.0	Electrical Power	1374.3	741.6	637.5		1379.1	1379.1
9.0	Propulsion	1590.2	519.0	1092.5		1611.5	1611.5
10.0	Reaction Control	280.2	279.8			279.8	279.8
11.0	Communications	127.7	109.7	19.9		129.6	129.6
12.0	Controls and Displays	191.6	194.0			194.0	194.0
13.0	Explosive Devices	48.7	11.5	34.0		45.5	45.5
Note:	Contractor Furnished Hardware	7361.0	3656.6	3707.0		7363.6	1.0 7364.6

LEM WEIGHT STATEMENT									
CODE	ITEM	5/1/66 WEIGHT AT SEPARATION	BURN OUT	CONS'D ON ASCENT	JET. ON LUNAR DESCENT	CURRENT WEIGHT STATUS		X-LUNAR EXPEND- ABLES	EARTH LAUNCH TOTAL
						CONS'D ON	TOTAL SEPARATION		
14.0	Government Furnished Equipment	1214.7	924.7		284.7		1209.4	-565.5	643.9
15.0	Liquids and Cases	432.0	111.1	12.3	300.5	9.9	433.8	8.3	442.1
16.0	Propellant - Delta V -Main -RCS	(21388.5) 21112.8 275.7	(4793.9) 4537.9 256.0	(16594.2) 16574.5 19.7	(21388.1) 21112.4 275.7		(21388.1) 21112.4 275.7	(4.4)	(915.3) 662.1 253.2
17.0	Propellant -Non Delta-V -Unusable -Attitude and Checkout	(910.9) 662.1 248.8	(210.5) 188.3 22.2	(56.6) 56.6	(478.2) 473.8 4.4	(165.6) 165.6	(910.9) 662.1 248.8	(4.4)	(915.3) 662.1 253.2
		31307.1	4902.9	4862.8	4770.4	16769.7	31305.8	-551.8	30754.0
	Burnout Weight	4902.5	4902.9 lbs.						
	Lift-off Weight	9765.0		9765.7 lbs.					
	Touchdown Weight	14536.7		14536.1 lbs.					
	Separation Weight	31307.1					31305.8 lbs.		
	Earth Launch Weight	30753.1							30754.0 lbs.

Table 5

LEM WEIGHT COMPARISON  
AT SEPARATION BY STAGES

<u>Subsystem</u>	<u>Item</u>	<u>5/1/66</u> <u>Weight</u>	<u>Current</u> <u>Weight</u>	<u>Weight</u>
A.	Ascent Stage Weight at Separation	<u>10063.3</u>	<u>10061.0</u>	<u>-2.3</u>
1.0	Structure	1179.7	1176.4	-3.3
2.0	Stabilization and Control	78.7	76.6	-2.1
3.0	Navigation and Guidance	71.3	71.3	0
4.0	Crew Provisions	73.2	73.1	- .1
5.0	Environmental Control	282.9	283.0	+ .1
6.0	Landing Gear	--	--	--
7.0	Instrumentation	125.8	128.2	+2.4
8.0	Electrical Power Supply	736.8	741.6	+4.8
9.0	Propulsion System	518.0	519.0	+1.0
10.0	Reaction Control	280.2	279.8	- .4
11.0	Communications	110.5	111.8	+1.3
12.0	Controls and Displays	191.6	194.0	+2.4
13.0	Explosive Devices	14.4	11.5	-2.9
14.0	Government Furnished Equipment	1024.7	1018.8	-5.9
15.0	Liquids & Gases - Excludes Propellant	125.1	125.2	+ .1
16.0	Propellant - Delta -V	(4813.3)	(4813.6)	(+ .3)
	-Main	4537.6	4537.9	+ .3
	-Reaction Control	275.7	275.7	0
17.0	Propellant - Non-Delta -V	(437.1)	(437.1)	(0)
	-Main (Unusable)	130.3	130.3	0
	-Reaction Control (58.0# Unusable)	306.8	306.8	0
B.	Descent Stage Weight at Separation	<u>21243.8</u>	<u>21244.8</u>	<u>+1.0</u>
1.0	Structure	1293.6	1273.8	-19.8
2.0	Stabilization and Control	14.2	14.2	0
3.0	Navigation and Guidance	37.8	37.8	0
4.0	Crew Provisions	--	--	--
5.0	Environmental Control	108.4	107.5	- .9
6.0	Landing Gear	477.2	476.3	- .9
7.0	Instrumentation	5.5	5.9	+ .4
8.0	Electrical Power Supply	637.5	637.5	0
9.0	Propulsion System	1072.2	1092.5	+20.3
11.0	Communications	17.2	17.8	+ .6
13.0	Explosive Devices	34.3	34.0	- .3
14.0	Government Furnished Equipment	190.0	190.6	+ .6
15.0	Liquids and Gases - Excludes Propellant	306.9	308.6	+1.7
16.0	Propellant - Delta -V -Main	16575.2	16574.5	- .7
17.0	Propellant - Propulsion (Unusable)	473.8	473.8	0
	Total Separation Weight (A & B)	<u>31307.1</u>	<u>31305.8</u>	<u>-1.3</u>

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION

	Inert* Wt. Chgs.		Effective Weight By Responsibility
	By Stages	By Stages	
	Ascent	Descent	GAEC
	(- 5.9)	(+ .6)	NASA (-17.7)
Current Weight of Government Furnished Equipment	+ .3		+ 1.2
The current individual weights of Government Furnished Equipment are updated in accordance with ref. 5 and ref. 17 and informal MSC discussions.	- 1.4		- 5.9
14.0 Government Furnished Equipment	- .5		- 2.1
-MIT Equipment - IMU	- .5		- 2.1
-PSA	- .3		- 1.2
-PTA	- .1		- .4
-SCA	+ .1		+ .4
-Lens Cleaning Kit (Transferred)	- .1		- .4
-Crew Provisions - PGA Waste Fitting	- .1		- .4
-Multiple Gas Stowage Plate	- .2		- .8
-Emergency Oxygen Mounting Pads	- 6.0		-19.0
-Emergency Oxygen (2)	+ .4		+ 1.2
-PLSS-Dry	- .4		- 1.2
-Battery	+ 2.0		+ 6.3
-LiOH Cartridge	- .8		- 1.7
-Water	+ .8		+ 3.4
-Spare PLSS LiOH Cartridges (4)	+ .3		+ 1.3
-Water Dispenser	+ .5		+ 1.2
-Spare PLSS Batteries		+ .6	+ 1.3
-Lens Cleaning Kit (Transferred)			+ 1.2
-Communications - T.V. Lens Stowage (Added)			+ 2.1
	(-10.1)	(-26.8)	(-99.4)

Super Weight Improvement Program

The current effects of the Super Weight Improvement Program (SWIP) for this reporting period are decreases of 26.8 pounds in the descent stage and 10.1 pounds in the ascent stage. A more detailed breakdown of the SWIP changes are as follows:

\* Inert weight excludes Δ V propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY  
AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	<u>Inert* Wt. Chgs.</u>		<u>Effective Weight</u>	
	<u>By Stages</u>	<u>Descent</u>	<u>By Responsibility</u>	<u>NASA</u>
	<u>Ascent</u>	<u>Descent</u>	<u>GAEC</u>	<u>NASA</u>
<u>Super Weight Improvement Program - Cont.</u>				
Scrape effort on 41 Ascent Structure drawings, 55 Descent Structure drawings and 9 Crew Provision drawings indicate weight reductions of 9.6 pounds, 21.4 pounds and .5 pounds respectively.				
1.0	- 9.6	- 21.4	- 85.8	
4.0	- .5		- 2.1	
Redesign of Descent Stage engine actuator support structure, SWIP change LMSS 280A-25, reflects the following weight change.				
1.0		- 5.4	- 11.5	
	(+ 5.4)	(- .8)	(+ 20.7)	
<u>Miscellaneous Vendor Weight Changes</u>				
Weight changes of vendored items based on current reported weights are as follows:				
2.0			- 7.5	
			- 1.2	
5.0			+ 15.1	
			- 11.3	
			- 1.7	
			+ .8	
			- 4.4	
7.0				
			+ .8	
			+ .8	
			+ 9.2	

\* Inert weight excludes ΔV propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY  
AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Miscellaneous Vendor Weight Changes - Cont.				
8.0 Electrical Power Supply	+ 1.2		+ 5.0	
-Lighting Controls	+ 3.0		+12.6	
-Circuit Breakers				
10.0 Reaction Control	- .6		- 2.5	
-Propellant Quantity Gaging Components	+ .2		+ .8	
-Cluster Heaters				
11.0 Communications	+ .1		+ .4	
-VHF Transceiver	+ 1.1		+ 4.6	
-VHF Signal Processor Assembly	+ .3	+ .4	+ 1.2	
-S-Band Steerable Antenna			+ .8	
-Erectable Antenna				
12.0 Controls and Displays - Lights, indicators, etc.	+ 2.4		+10.0	
13.0 Explosive Devices	- .3	- .3	- 1.9	
-Disconnect Valves	- 2.0		- 8.4	
-Circuit Interrupter	- .2		- .8	
-Connectors	- .4		- 1.7	
-Umbilical Cutter Assembly				
Miscellaneous Weight Changes	(+ 8.2)	(+28.5)	(+81.0)	(+14.1)
Continuing review and updating of the vehicle structure and the landing gear structure indicates a 3.0 pound increase in the ascent stage structure, a 7.0 pound increase in the descent stage structure and a .9 pound decrease in the landing gear.				
1.0 Structure	+ 3.0	+ 7.0	+27.5	
6.0 Landing Gear	-	- .9	- 1.9	

Current Crew Provision drawings and layouts update previous weights and indicate the addition of an AOT protective cage.

\* Inert weight excludes Δ V propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	<u>Inert* Wt. Chgs.</u>	<u>Effective Weight</u>
	<u>By Stages</u>	<u>By Responsibility</u>
	<u>Ascent</u>	<u>GAEC</u>
	<u>Descent</u>	<u>NASA</u>

Miscellaneous Weight Changes - Cont.

A portion of the storage and supports for additional government furnished components are included at this time.

1.0 Structure	+ 1.3	+ 3.4	+ 5.4
-GFE Supports	+ .8	+ 7.1	
-AOT Protective Cage	+ 1.7	-	
-Miscellaneous	-	.4	
4.0 Crew Provisions - Miscellaneous			

Two over 50 AMP circuit breakers were added to serve the cross tie function.

8.0 Electrical Power Supply - Circuit Breakers	+ .6	+ 2.5	
--	------	-------	--

The drop in propellant temperature during the mission reduces the propellant tank pressure. The Gruman proposed electrically heated start-pressurization scheme was disapproved. MSC requested that an ambient storage of start-up helium be used in conjunction with the DPS supercritical helium system to meet operating conditions. The weight effect of this change for other than the Propulsion subsystem currently appears under pending changes and will be incorporated in subsequent reports.

9.0 Propulsion - Helium Tank, plumbing, etc..	+11.7	+18.6	+ 6.4
15.0 Liquids and Gases - Helium	+ 1.1		+ 2.3

Added test points to check pressurization and feed system components.

9.0 Propulsion	+ 2.2	+ 4.7	
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\* Inert weight excludes ΔV propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	<u>Inert* Wt. Chgs. By Stages</u>	<u>Effective Weight By Responsibility</u>
	<u>Ascent</u>	<u>GAEC</u>
	<u>Descent</u>	<u>NASA</u>
	+ 4.4	+ 9.4
	+ 1.0	+ 2.0
	+ .2	+ .8
	- .4	- .9
	+ .1	+ 1.7
	<u>- 2.4</u>	<u>+ 2.3</u>
	+ 1.5	<u>- 3.6</u>

Miscellaneous Weight Changes - Cont.

The capability to manually vent the descent propellant tanks on the lunar surface is being incorporated as a result of the Critical Design Review. Only a portion of this change is incorporated at this time. The remaining portion appears under Pending Changes and will be reported in subsequent reports.

9.0 Propulsion

Zero "G" devices are added to the propellant tank assemblies to prevent gas from entering the engine feed lines during zero "G" flight. The remaining weight effects of this change appears under pending changes and will be reported in subsequent reports.

9.0 Propulsion - Zero "G" devices

Nitrogen, required to pressurize the water tanks, has been inadvertently omitted from the weight report. Also the location of two disconnects were corrected and two check valves added.

5.0 Environmental Control

-Check valves

-Disconnects

15.0 Liquids and Gases - Nitrogen

TOTAL INERT WEIGHT CHANGES

TOTAL EFFECTIVE WEIGHT CHANGES BY RESPONSIBILITY

TOTAL REPORTED WEIGHT CHANGES = -1.3 pounds

\* Inert weight excludes Δ V propellant.

Pending Changes

	<u>Estimated Weight Increment</u>		
	<u>Ascent</u> <u>(Inert*)</u>	<u>Descent</u> <u>(Inert*)</u>	<u>Separation</u> <u>(Effective)</u>
1. Incorporate the stowage provisions for additional Government Furnished Equipment.	+ 2.1	-	+ 8.8
2. Eliminate Landing Gear Thermal Paint from the Primary and Secondary Struts since the paint does not appear to be an effective regulator of the honeycomb cartridge temperature. Wrapping NRC-2 around the struts is a solution currently under study.		+ 2.1	+ 4.5
3. Incorporate the Optical Tracker Installation in lieu of the Rendezvous Radar and the Alignment Optical Telescope.	-80.2		-335.9
4. Reduce battery cell cases to .050 in. thickness - SWIP change LWSS 390A-53.	- 4.0	- 8.0	-33.8
5. Resize LUT dead-face relay for LEM 4 and subsequent due to lower power requirements - SWIP change LWSS 390A-17.	- 1.0		- 4.2
6. Review and revise the unusable propellant philosophy.	+ 1.3	-98.8	-205.3
7. Estimate weight of cluster heaters (8) based on the latest design.	+ .5		+ 2.1
8. Add ambient helium pre-pressurization tank and associated controls to Descent Propulsion System to insure helium flow if propellant system is not fully pressurized. (Partially incorporated.)	(+ 1.6)	(+ 6.6)	(+20.8)
Propulsion	0	+ .4	+ .9
Instrumentation, Displays and Control	+ 1.0	+ .3	+ 4.8
Electrical Power	+ .6	+ 2.9	+ 8.7
Structure	0	+ 3.0	+ 6.4
9. Cant Ascent Engine to reduce lateral distance between Engine thrust vector and vehicle's center of gravity, and thus lessen the RCS Control requirements.	(+ 7.7)		(+32.2)
Structure	+ 5.0		+20.9
Trapped Propellant	+ 2.7		+11.3

\*Inert weight excludes  $\Delta V$  Propellant.

Pending Changes - Cont.

	<u>Estimated Weight Increment</u>		
	<u>Ascent</u> <u>(Inert*)</u>	<u>Descent</u> <u>(Inert*)</u>	<u>Separation</u> <u>(Effective)</u>
10. Add hat sections and screens to descent and ascent propellant tanks to insure propellant remains in the main feed lines during "0" G operation and prior to Engine Start. (Partially incorporated.)	+ 4.2	+13.6	+46.6
11. Incorporation of the chits, submitted and approved for Critical Design Review (CDR) Part #1, reflect the following weight changes:	(+14.2)	(+ 4.6)	(+69.3)
Structure	+ .3	+ 9.9	+22.4
Landing Gear	-	-	-
Electro-Explosive Devices	+10.5	- 9.5	+23.7
Navigation and Guidance	+ .4	0	+ 1.7
Propulsion	+ 2.0	+ 4.2	+17.3
Reaction Control	+ 1.0	0	+ 4.2
12. Incorporation of the chits, submitted and approved for CDR Part #2, reflect the following weight changes:	(+11.3)	(+ 2.5)	(+52.8)
Crew Provisions	+ 1.5	+ 1.0	+ 8.4
Environmental Control	+ .4	0	+ 1.7
Instrumentation	+ 4.0	0	+16.8
Electrical Power Supply	+ .3	0	+ 1.3
Communications	0	0	0
Controls and Displays	+ 5.1	+ 1.5	+24.6
13. Apply the required silicone coating to help maintain the proper emissivity values and thus meet the thermal control requirements.			
Internal Surface of Cabin Area	+10.2		+42.7
Exterior Surface of Thermal Shielding	+ .5	+ .5	+ 3.2
14. Cover the Landing Gear Pads with ablative material to protect the pads from the high temperatures, that are expected to be encountered during the landing phase of the mission.		+ 8.4	+17.9

\* Inert weight excludes  $\Delta V$  propellant.

Pending Changes - Cont.

	<u>Estimated Weight Increment</u>		
	<u>Ascent</u> <u>(Inert*)</u>	<u>Descent</u> <u>(Inert*)</u>	<u>Separation</u> <u>(Effective)</u>
15. Relocate two descent batteries to alleviate a c.g. problem. This lateral movement of batteries will reduce head differential in Descent Propellant Tanks and thus minimize the unuseable propellant. This reduction in unuseable propellant is in addition to that shown in Pending Change #6.			
Relocation Hardware		+23.6	+50.3
Reduction in unuseable propellant		-73.0	-155.6

\* Inert weight excludes  $\Delta V$  Propellant.

GOVERNMENT FURNISHED EQUIPMENT

This report incorporates Government Furnished Equipment Current Weights per reference 5. Table 6 is listings of these GFE items and their weights under the following three categories:

A. Items Aboard LEM at Earth Launch	643.9 pounds
B. Items Transferred to LEM From CSM	565.5 pounds
C. Items Returned to Lunar Orbit	924.7 pounds

The current weights of the MIT equipment is reported in accordance with reference 17. This differs from weights shown in reference 5, which reflects the weights of an earlier revision of reference 17.

Table 6 includes a LEM/CSM docking receptacle. This added item and a lower drogue weight deviate from reference 5 based on informal discussions with MSC.

Table 6

GOVERNMENT FURNISHED EQUIPMENT - CURRENT WEIGHT

<u>Code</u>	<u>Item</u>	<u>Qty</u>	<u>Current Weight</u>
A.	Items Aboard LEM At Earth Launch		<u>643.9</u>
14.1	<u>Structure</u>		(17.2)
14.1.1	Drogue		17.2
14.3	<u>MIT Equipment</u>		(251.1)
14.3.2	-IMU Platform (includes integral coolant facilities)		42.4
14.3.3	-AOT Telescope		23.1
14.3.4	-LGC Computer		65.0
14.3.5	-PSA Servo		19.2
14.3.6	-Harness "A"		14.6
14.3.7	-Harness "B"		4.5
14.3.8	-Navigation Base		4.0
14.3.9	-PTA Torquer		14.3
14.3.10	-SCEA		7.2
14.3.11	-CDU Converter		37.3
14.3.14	-DSKY Data Storage Key		17.5
14.3.15	-AOT Button Box		2.0
14.4	<u>Crew Provisions</u>		(150.4)
14.4.1.1.1	EV Gloves		1.7
14.4.1.1.2	Thermal Meteoroid Garment - Parka and Trousers		9.5
14.4.1.1.3	-EV Boots	2	8.0
14.4.1.1.4	-EV Mittens		.4
14.4.1.1.5	-Helmet and PLSS Cover		1.4
14.4.1.1.6	EMU Maintenance Kit		2.0
14.4.1.1.7	Oxygen Waste Fitting		.2
14.4.1.1.8	Water Waste Fitting		.2
14.4.1.1.9	PGA Waste Fitting		.1
14.4.1.1.10	PLSS Condensate Removal Fitting		.2
14.4.1.1.11	Multiple Gas Connector	4	1.2
14.4.1.1.12	Multiple Gas Stowage Plate	2	.8
14.4.1.1.13	Emergency Oxygen Mounting Pads	2	.3
14.4.1.1.14	Portable Life Support System - Dry		47.8
14.4.1.1.15	-Battery		5.2
14.4.1.1.16	-LiOH Cartridge		3.8
14.4.1.1.17	-Oxygen		1.0
14.4.1.1.18	-Water		8.6
14.4.1.1.19	PLSS LiOH Cartridges	4	15.2
14.4.1.1.20	Lens Cleaning Kit	1	.3
14.4.1.2.1	Water Dispenser		1.3
14.4.1.2.2	Food		8.8
14.4.1.2.3	Fecal Gloves	6	1.1
14.4.1.3.1	Inflight Tools		1.4
14.4.1.4.1	Flight Data Kit-Check lists & Experiments Data		6.1

Table 6 - Cont.

GOVERNMENT FURNISHED EQUIPMENT - CURRENT WEIGHT

<u>Code</u>	<u>Item</u>	<u>Qty</u>	<u>Current Weight</u>
14.4	<u>Crew Provisions</u> - Cont.		
14.4.1.4.2	Sequence Camera		1.6
14.4.1.4.4	-Magazine		.6
14.4.1.4.3	-Lenses		.5
14.4.1.6	Survey Meter Bracket		.5
14.4.11.1	PLSS Batteries	4	20.6
14.7	<u>Instrumentation</u>		(219.0)
14.7.1	Scientific Equipment - Specimen Return Containers	2	23.0
14.7.3.1	Tape and Film Container		16.0
14.7.3.2	Sequence Camera Extra Film Container		10.0
14.7.11.1.1	Scientific Equipment - Lunar Surface Experiments		150.0
14.7.11.1.2	-Lunar Tools		20.0
14.8	<u>Electrical</u>		(3.2)
14.8.0	LEM/CSM-Docking Receptacle		.1
14.8.1	-Electrical Umbilical		3.1
14.11	<u>Communications</u>		(3.0)
14.11.1.5.1	Television Camera - Lunar Night Lens		.4
14.11.1.5.2	-Portable 9-foot cable		.6
14.11.1.5.3	-Connector, Receptacle		.2
14.11.1.5.4	-Stowage Frame		1.3
14.11.1.5.5	-Lens Stowage		.5
B.	Items Transferred to LEM from CSM		<u>565.5</u>
14.4	<u>Crew Provisions</u>		(529.4)
14.4.2.0.1	Crew - Systems Engineer		176.0
14.4.2.0.2	-Commander		176.0
14.4.2.1.1	Pressure Garment Assembly - Commander		32.9
14.4.2.1.2	-Systems Engineer		32.9
14.4.2.1.3	EV Visors	2	5.0
14.4.2.1.4	EV Gloves		1.7
14.4.2.1.5	Thermal Meteoroid Garment - Parka & Trousers		9.5
14.4.2.1.6	-EV Mittens		.4
14.4.2.1.7	-Helmet and PLSS Cover		1.4
14.4.2.1.8	Liquid Cooled Garment - Commander		3.9
14.4.2.1.9	-Systems Engineer		3.9
14.4.2.1.10	Helmet Stowage Containers	2	1.0
14.4.2.1.11	Portable Life Support System - Dry		47.8
14.4.2.1.12	-Battery		5.2
14.4.2.1.13	-LiOH Cartridge		3.8

Table 6 - Cont.

GOVERNMENT FURNISHED EQUIPMENT - CURRENT WEIGHT

<u>Code</u>	<u>Item</u>	<u>Qty</u>	<u>Current Weight</u>
14.4	Crew Provisions - Cont.		
14.4.2.1.14	-Oxygen		1.0
14.4.2.1.15	-Water		8.6
14.4.2.1.16	Emergency Oxygen	2	5.8
14.4.2.2.1	EV Crew Transfer		6.0
14.4.2.2.2	Bioinstrumentation	2	2.2
14.4.2.4.1	Flight Data Kit - LEM Flight Plan		.9
14.4.2.4.2	Sequence Camera - Magazine		.6
14.4.2.6	Personal Whole Body Dosimeters		.9
14.4.2.6.3	Survey Meter		1.8
14.4.2.6.4	Passive Dosimeters		.2
14.7	Instrumentation		(31.0)
14.7.1.1	Scientific Equipment - Still Camera Package		15.0
14.7.1.2	-Undefined		16.0
14.8	Electrical		(-3.1)
14.8.1	LEM/CM - Electrical Umbilical		-3.1
14.11	<u>Communications</u>		(8.2)
14.11.2.5.1	Television Camera		7.2
14.11.2.5.2	-Telephoto Lens		1.0
C.	Items Returned to Lunar Orbit		<u>924.7</u>
14.1	<u>Structure</u>		(17.2)
14.1.1	Drogue		17.2
14.3	<u>MIT Equipment</u>		(251.1)
14.3.2	-IMU platform (includes integral coolant facilities)		42.4
14.3.3	-AOT Telescope		23.1
14.3.4	-LGC Computer		65.0
14.3.5	-PSA Servo		19.2
14.3.6	-Harness "A"		14.6
14.3.7	-Harness "B"		4.5
14.3.8	-Navigation Base		4.0
14.3.9	-PTA Torquer		14.3
14.3.10	-SCEA		7.2
14.3.11	-CDU Converter		37.3
14.3.14	-DSKY Data Storage Key		17.5
14.3.15	-AOT Button Box		2.0

Table 6 - Cont.

GOVERNMENT FURNISHED EQUIPMENT - CURRENT WEIGHT - Cont.

<u>Code</u>	<u>Item</u>	<u>Qty</u>	<u>Current Weight</u>
C.	Items Returned to Lunar Orbit - Cont.		
14.4	Crew Provisions		(565.5)
14.4.1.1.1	EV Gloves		1.7
14.4.1.1.2	Thermal Meteoroid Garment - Parka and Trousers		9.5
14.4.1.1.4	-EV Mittens		.4
14.4.1.1.5	-Helmet and PLSS Cover		1.4
14.4.1.1.7	Oxygen Waste Fitting		.2
14.4.1.1.8	Water Waste Fitting		.2
14.4.1.1.9	PGA Waste Fitting		.1
14.4.1.1.10	PLSS Condensate Removal Fitting		.2
14.4.1.1.11	Multiple Gas Connector	4	1.2
14.4.1.1.12	Multiple Gas Stowage Plate	2	.8
14.4.1.1.13	Emergency Oxygen - Mounting Pads	2	.3
14.4.1.1.20	Lens Cleaning Kit		.3
14.4.1.2.1	Water Dispenser		1.3
14.4.1.2.2	Food		8.8
14.4.1.2.3	Fecal Gloves	6	1.1
14.4.1.3.1	Inflight Tools		1.4
14.4.1.4.1	Flight Data Kit - LEM Flight Plan		.9
14.4.1.4.2	Sequence Camera-Magazine		.6
14.4.1.6.1	Survey Meter Bracket		.5
14.4.2.0.1	Crew - Systems Engineer		176.0
14.4.2.0.2	-Commander		176.0
14.4.2.1.1	Pressure Garment Assembly - Commander		32.9
14.4.2.1.2	-Systems Engineer		32.9
14.4.2.1.3	EV Visors	2	5.0
14.4.2.1.4	EV Gloves		1.7
14.4.2.1.5	Thermal Meteoroid Garment - Parka and Trousers		9.5
14.4.2.1.6	-EV Mittens		.4
14.4.2.1.7	-Helmet and PLSS Cover		1.4
14.4.2.1.8	Liquid Cooled Garment - Commander		3.9
14.4.2.1.9	-Systems Engineer		3.9
14.4.2.1.10	Helmet Stowage Containers	2	1.0
14.4.2.1.11	Portable Life Support System - Dry		47.8
14.4.2.1.12	-Battery		5.2
14.4.2.1.13	-LiOH Cartridge		3.8
14.4.2.1.14	-Oxygen		1.0
14.4.2.1.15	-Water		8.6
14.4.2.1.16	Emergency Oxygen	2	5.8
14.4.2.2.1	Crew Transfer		6.0
14.4.2.2.2	Bioinstrumentation	2	2.2
14.4.2.4.1	Flight Data Kit - Check lists & Experiments Data		6.1
14.4.2.4.2	Sequence Camera-Magazine		.6
14.4.2.6	Personal Whole Body Dosimeters		.9
14.4.2.6.3	Survey Meter		1.8
14.4.2.6.4	Passive Dosimeters		.2

Table 6 - Cont.

GOVERNMENT FURNISHED EQUIPMENT - CURRENT WEIGHT - Cont.

<u>Code</u>	<u>Item</u>	<u>Qty</u>	<u>Current Weight</u>
14.7	<u>Instrumentation</u>		(80.0)
14.7.1	Sample Containers	2	23.0
14.7.1.3	Scientific Equipment - Lunar Samples		31.0
14.7.2.1	Tape and Film Container		16.0
14.7.2.2	Sequence Camera Extra Film Container		10.0
14.8	<u>Electrical</u>		(.1)
14.8.0	LEM/CM-Docking Receptacle		.1
14.11	<u>Communications</u>		(10.8)
14.11.1.5.2	Television Camera - Portable 9-foot cable		.6
14.11.1.5.3	-Connector, Receptacle		.2
14.11.2.5.1	-Camera		7.2
14.11.2.5.2	-Telephoto Lens		1.0
14.11.1.5.4	-Stowage Frame		1.3
14.11.1.5.5	-Lens Stowage		.5

TOTAL GOVERNMENT FURNISHED EQUIPMENT AT SEPARATION = 1209.4 lbs

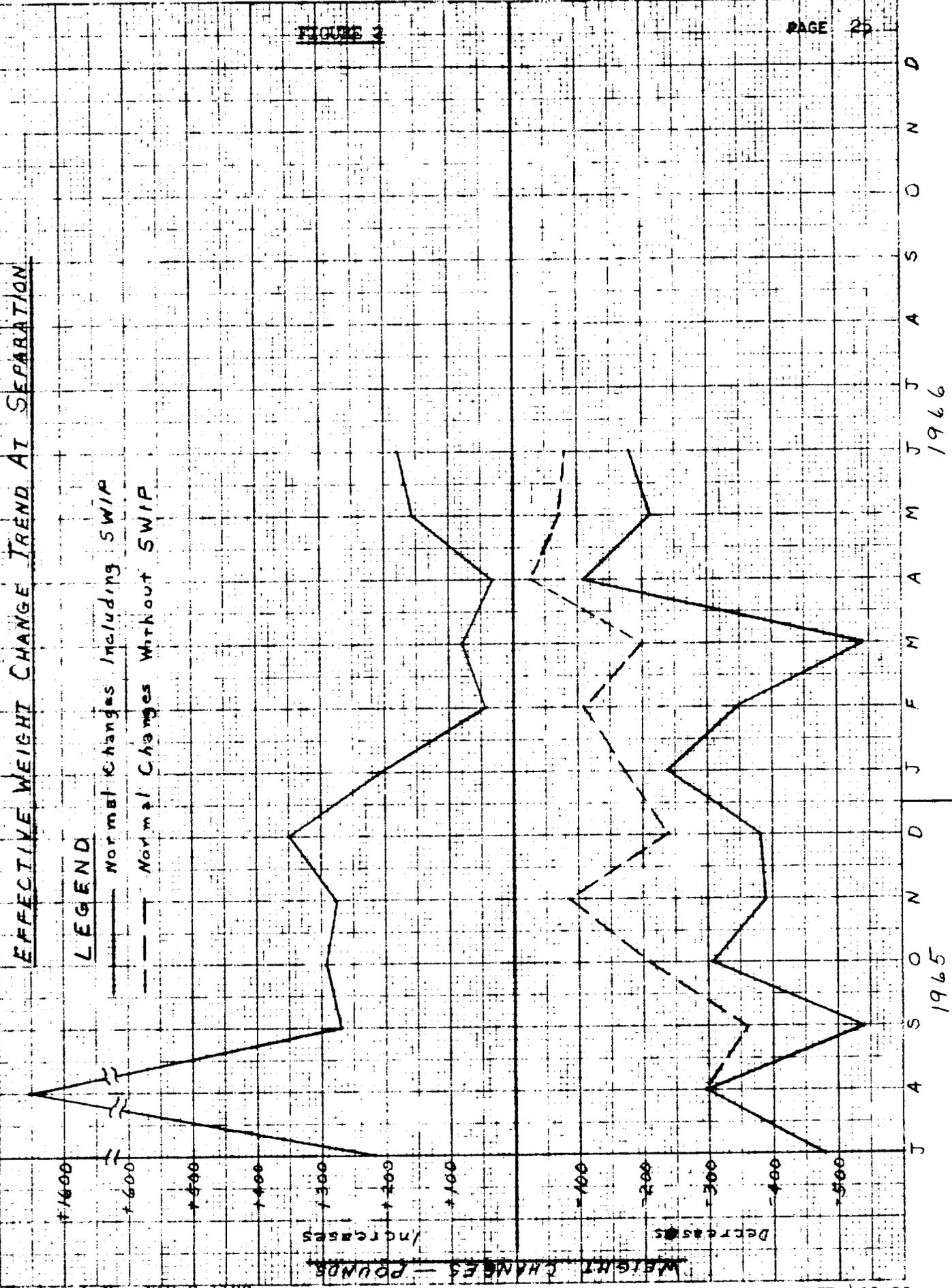
TOTAL GOVERNMENT FURNISHED EQUIPMENT RETURNED TO LUNAR ORBIT = 924.7 lbs

EFFECTIVE WEIGHT CHANGE TREND AT SEPARATION

LEGEND

— Normal Changes Including SWIP

- - - Normal Changes Without SWIP



LEM-1 STATUSWEIGHT COMPARISONS BY STAGES AT EARTH LAUNCH

		<u>Weight</u>		
		<u>5/1/66</u>	<u>Current</u>	<u>Delta</u>
A.	Ascent Stage Inert Weight at E. L.	<u>5200.3</u>	<u>5115.4</u>	<u>-84.9</u>
1.0	Structure	1304.3	1327.5	+23.2
2.0	Stabilization and Control	78.7	76.6	- 2.1
3.0	Navigation and Guidance	71.3	71.3	0
4.0	Crew Provisions	73.2	74.3	+ 1.1
5.0	Environmental Control	283.2	283.8	+ .6
7.0	Instrumentation	125.8	128.2	+ 2.4
8.0	Electrical Power Supply	829.3	834.1	+ 4.8
9.0	Propulsion System	525.3	525.3	0
10.0	Reaction Control	295.7	295.3	- .4
11.0	Communications	106.2	107.5	+ 1.3
12.0	Controls and Displays	191.6	194.0	+ 2.4
13.0	Explosive Devices	14.4	15.1	+ .7
	Hardware-Sub-Total	(3899.0)	(3933.0)	(+34.0)
14.0	Government Furnished Equipment	351.3	348.1	- 3.2
15.0	Liquids & Gases - Excludes Propellant	118.2	118.3	+ .1
17.0	Propellant - Unusable	188.3	188.3	0
19.0	R & D Equipment & Misc.	643.5	527.7	-115.8
B.	Descent Stage Inert Weight at E. L.	<u>4838.5</u>	<u>4733.9</u>	<u>-104.6</u>
1.0	Structure	1328.8	1340.7	+11.9
2.0	Stabilization and Control	14.2	14.2	0
3.0	Navigation and Guidance	37.8	37.8	0
5.0	Environmental Control	108.4	107.5	- .9
6.0	Landing Gear	477.2	476.3	- .9
7.0	Instrumentation	5.5	5.9	+ .4
8.0	Electrical Power Supply	649.3	649.3	0
9.0	Propulsion System	1096.6	1114.9	+18.3
11.0	Communications	4.5	4.7	+ .2
13.0	Explosive Devices	34.3	34.0	- .3
	Hardware-Sub-Total	(3756.6)	(3785.3)	(+28.7)
14.0	Government Furnished Equipment	--	--	--
15.0	Liquids and Gases - Excludes Propellant	322.1	323.8	+ 1.7
17.0	Propellant - Propulsion (Unusable)	473.8	473.8	0
19.0	R & D Equipment & Misc.	286.0	151.0	-135.0
<u>TOTAL INERT WEIGHT AT E. L. (A &amp; B)</u>		<u>10038.8</u>	<u>9849.3</u>	<u>-189.5</u>

<u>LEM-1 Unmanned Condition</u>	<u>Control</u>	<u>Current</u>
	<u>Weight</u>	<u>Weight</u>
Ascent stage inert at Earth Launch	5540	5115
Descent stage inert at Earth Launch	5200	4734
RCS Propellant	550*	540
Ascent Main Propellant	5015*	5070
Descent Main Propellant	<u>17000*</u>	<u>17513</u>
Total Vehicle - Earth Launch	33305**	32972**

\* Ref. 4 indicates that the propellant requirements are approximate.

\*\* Design Weight at Earth Launch is 32,000 pounds.

LEM-2 STATUSWEIGHT COMPARISONS BY STAGES AT EARTH LAUNCH

		Weight		
		<u>5/1/66</u>	<u>Current</u>	<u>Delta</u>
A.	Ascent Stage Inert Weight at E. L.	5282.6	5195.1	-87.5
1.0	Structure	1305.7	1328.8	+23.1
2.0	Stabilization and Control	78.7	76.6	- 2.1
3.0	Navigation and Guidance	71.3	71.3	0
4.0	Crew Provisions	73.2	74.3	+ 1.1
5.0	Environmental Control	283.2	283.8	+ .6
7.0	Instrumentation	125.8	128.2	+ 2.4
8.0	Electrical Power Supply	829.3	834.1	+ 4.8
9.0	Propulsion System	525.3	525.3	0
10.0	Reaction Control	295.7	295.3	- .4
11.0	Communications	106.2	107.5	+ 1.3
12.0	Controls and Displays	191.6	194.0	+ 2.4
13.0	Explosive Devices	14.4	15.1	+ .7
	Hardware-Sub-Total	(3900.4)	(3934.3)	(+33.9)
14.0	Government Furnished Equipment	388.2	385.0	- 3.2
15.0	Liquids & Gases - Excludes Propellant	118.2	118.3	+ .1
17.0	Propellant - Unusable	188.3	188.3	0
19.0	R & D Equipment & Misc.	687.5	569.2	-118.3
B.	Descent Stage Inert Weight at E. L.	4512.9	4513.0	+ .1
1.0	Structure	1293.6	1273.2	-20.4
2.0	Stabilization and Control	14.2	14.2	0
3.0	Navigation and Guidance	37.8	37.8	0
5.0	Environmental Control	108.4	107.5	- .9
6.0	Landing Gear	477.2	476.3	- .9
7.0	Instrumentation	5.5	5.9	+ .4
8.0	Electrical Power Supply	649.3	649.3	0
9.0	Propulsion System	1076.2	1096.5	+20.3
11.0	Communications	4.5	4.7	+ .2
13.0	Explosive Devices	34.3	34.0	- .3
	Hardware-Sub-Total	(3701.0)	(3699.4)	(- 1.6)
14.0	Government Furnished Equipment	--	--	--
15.0	Liquids and Gases - Excludes Propellant	322.1	323.8	+ 1.7
17.0	Propellant - Propulsion (Unusable)	473.8	473.8	0
19.0	R & D Equipment & Misc.	16.0	16.0	0
TOTAL INERT WEIGHT AT E. L. (A & B)		9795.5	9708.1	-87.4

	<u>Proposed</u>	<u>Current</u>
<u>LEM-2 Manned Condition</u>	<u>Weight</u>	<u>Weight</u>
Ascent Stage inert at Earth Launch	5310	5195.1
Descent Stage inert at Earth Launch	4680	4513.0
RCS Propellant	540*	540.0
Ascent Main Propellant	5090*	5070.0
Descent Main Propellant	17355*	17513.0
Total Vehicle - Earth Launch	32975**	32831.1**

\* Propellant requirements are approximate.

\*\* Design Weight at Earth Launch is 32,000 pounds.

LEM-3 STATUSWEIGHT COMPARISONS BY STAGES AT EARTH LAUNCH

		<u>Weight</u>		
		<u>5/1/66</u>	<u>Current</u>	<u>Delta</u>
A.	Ascent Stage Inert Weight at E. L.	<u>4932.8</u>	<u>4925.1</u>	- 7.7
1.0	Structure	1183.0	1175.0	- 8.0
2.0	Stabilization and Control	78.7	76.6	- 2.1
3.0	Navigation and Guidance	71.3	71.3	0
4.0	Crew Provisions	73.2	74.3	+ 1.1
5.0	Environmental Control	283.5	284.0	+ .5
7.0	Instrumentation	125.8	128.2	+ 2.4
8.0	Electrical Power Supply	829.3	834.1	+ 4.8
9.0	Propulsion System	524.6	525.6	+ 1.0
10.0	Reaction Control	280.2	279.8	- .4
11.0	Communications	106.2	107.5	+ 1.3
12.0	Controls and Displays	191.6	194.0	+ 2.4
13.0	Explosive Devices	14.4	15.1	+ .7
	Hardware-Sub-Total	(3761.8)	(3765.5)	(+ 3.7)
14.0	Government Furnished Equipment	397.0	393.8	- 3.2
15.0	Liquids & Gases - Excludes Propellant	118.2	118.3	+ .1
17.0	Propellant - Unusable	188.3	188.3	0
19.0	R & D Equipment & Misc.	467.5	459.2	- 8.3
B.	Descent Stage Inert Weight at E. L.	<u>4532.9</u>	<u>4533.6</u>	+ .7
1.0	Structure	1293.6	1273.2	-20.4
2.0	Stabilization and Control	14.2	14.2	0
3.0	Navigation and Guidance	37.8	37.8	0
5.0	Environmental Control	108.4	107.5	- .9
6.0	Landing Gear	477.2	476.3	- .9
7.0	Instrumentation	5.5	5.9	+ .4
8.0	Electrical Power Supply	649.3	649.3	0
9.0	Propulsion System	1076.2	1096.5	+20.3
11.0	Communications	4.5	4.7	+ .2
13.0	Explosive Devices	34.3	34.0	- .3
	Hardware-Sub-Total	(3701.0)	(3699.4)	(- 1.6)
14.0	Government Furnished Equipment	20.0	20.6	+ .6
15.0	Liquids and Gases - Excludes Propellant	322.1	323.8	+ 1.7
17.0	Propellant - Propulsion (Unusable)	473.8	473.8	0
19.0	R & D Equipment & Misc.	16.0	16.0	0
<u>TOTAL INERT WEIGHT AT E. L. (A &amp; B)</u>		<u>9465.7</u>	<u>9458.7</u>	- 7.0

<u>LEM-3 Manned Condition</u>	<u>Proposed Control</u>		<u>Current</u>
	<u>Weight</u>		<u>Weight</u>
Ascent Stage inert at Earth Launch	5225		4925.1
Descent Stage inert at Earth Launch	4845		4533.6
RCS Propellant	540*		540.0
Ascent Main Propellant	5090*		5070.0
Descent Main Propellant	<u>17585*</u>		<u>17513.0</u>
Total Vehicle - Earth Launch	33285**		32581.7**

\* Propellant requirements are approximate.

\*\* Design Weight at Earth Launch is 32,000 pounds.

LIST OF REFERENCES

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2. MSC letter PP6-13-64-646, dated 20 November 1964, "Contract NAS 9-1100, LEM Weight Report."
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4. MSC letter PS5/L231-13-65-1077, dated 9 December 1965, "Contract NAS 9-1100, Control Weights for LEM-1 (U)."
5. MSC letter PD3/L3010-13-66-346, dated 5 May 1966, "Contract NAS 9-1100, GFE specification weights and current weights."
6. LED-490-23, dated 1 August 1965, "LEM Mass Property Report (U)."
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8. LED-490-100 Revision B, Re-issued 15 February 1965, Allocation of Propellants and  $\Delta V$  to Meet the  $\Delta V$  Budget."
9. LAV-500-155, dated 6 July 1965, "Required  $\Delta V$  for Abort Using the Ascent Engine."
10. LMO-280-97, dated 7 February 1966, "Required Revisions To Vehicle Structure For Increased Landing Loads."
11. LMO-310-247, dated 9 September 1965, "RCS Mission and Residual Propellant Requirements (U)."
12. LMO-490-165, dated 10 February 1965, "Ascent and Descent Main Propellant Allocation, Criteria and Assumptions."
13. LMO-500-352, dated 6 December 1965, "Estimated RCS Propellant Required for LEM Attitude Maneuvers and Control for a Typical Lunar Mission."
14. LMU-340-50025, dated 25 September 1964, Inboard Profile.
15. LDW-280-10050, Revision E, dated 26 May 1965, "Geometry Ascent Stage -2 Tank" Drawing.
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APPENDIX ASWIP ITEMS INCORPORATED IN WEIGHT REPORTS

A breakdown of the SWIP items incorporated to date in the LEM Weight Report is as follows:

<u>LWSS</u> <u>Number</u>	<u>SWIP Items</u>	<u>Inert Weight</u> <u>By Stage</u>		<u>Effective</u> <u>Weight</u>
		<u>Ascent</u>	<u>Descent</u>	
	LED-490-25 Scrape Effort	-22.1		-93.0
	LED-490-26 Scrape Effort	-62.2	-12.5	-288.2
	LED-490-27 Scrape Effort	-13.9	- 8.8	-77.3
	LED-490-28 Scrape Effort	- 8.7	- 9.2	-56.1
	LED-490-29 Scrape Effort	- 4.6	-26.6	-76.0
	LED-490-30 Scrape Effort		- 8.8	-18.8
	LSR-490-31 Scrape Effort	- 5.5	-21.6	-69.1
	LSR-490-32 Scrape Effort	- 3.4	-17.0	-50.5
	LSR-490-33 Scrape Effort	-10.1	-21.4	-87.9
270A-5(b)	Aluminum in lieu of Steel Diffusers.	- .7	- .6	- 4.2
270A-40	Scrape of Ascent Engine	- 2.9		-12.1
270A-46	Scrape of Descent Engine		-11.4	-24.3
270B-8	Remove redundancy of helium pressurization regulators.		- 4.0	- 8.5
270B-16	Delete baffles in LEM propellant tanks.	- 8.8	-38.0	-146.8
280A-20	Trim excess weight on cold plates in aft equipment bays.	- 1.6		- 6.7
280A-25	Redesign of Descent Stage engine actuator support structure.		- 5.4	-11.5
280A-53	Optimize Descent Propellant Tanks		-20.0	-42.6
280A-58	Re-arrange equipment on aft rack to eliminate ECA overhang and shorten wire runs.	- 1.0		- 4.2

## APPENDIX A

SWIP ITEMS INCORPORATED IN WEIGHT REPORTS - Cont.

<u>LWSS Number</u>	<u>SWIP Items</u>	<u>Inert Weight By Stage</u>		<u>Effective Weight</u>
		<u>Ascent</u>	<u>Descent</u>	
310B-1	Removal of redundant RCS pressurization components.	-13.1		-54.9
310B-2	Reduction in safety factor on RCS pressurization bottles from 2.0 to 1.5.	- 5.4		-22.6
310B-6	Delete latching solenoid valve from two RCS helium pressurization systems.	- 4.4		-18.5
320A-10	Replace compression deployment spring and surrounding can with curved leaf spring . (Descent Corner Post portion * This 1.6 pounds was reported as scrape effort in LED-490-29.)		- 1.6	- 3.4
340B-5	Reduce weight of GFE thermal/meteoroid garment.	-11.0		-46.3
360A-2	Optimize Data Storage Electronics Assembly.	- .1		- .4
360A-3	Optimize Caution and Warning Electronics Assembly.	- .5		- 2.1
360A-5	Optimize Signal Conditioner Electronics Assembly.	-10.6		-44.3
360B-2	Optimize Pulse Code Modulation and Timing Electronics Assembly.	-14.3		-59.9
370A-2	Eliminate stroke adjustment on gimbal drive actuator.		- .4	- .8
380A-11	Scrape of Steerable Antenna	- 3.8		-15.9
380B-2	Delete 80-foot cable for use of external TV. Also delete tripod and 10-inch cable.	- 1.3	- 3.0	-10.2

APPENDIX ASWIP ITEMS INCORPORATED IN WEIGHT REPORTS - Cont.

<u>LWSS Number</u>	<u>SWIP Items</u>	<u>Inert Weight</u>		<u>Effective Weight</u>
		<u>Ascent</u>	<u>Descent</u>	
390A-21	Reduce functional requirements of lighting control assembly.	- 9.0		-37.6
390A-52	Optimize General Purpose Inverter	- .8		- 3.3
390B-2	Single Wire Electrical System using LEM Structure as ground.	-14.8		-62.0
390B-12 (Phase 2)	Eliminate automatic switchover circuitry for ECS glycol pumps.	- 1.5		- 6.3
510A-1	Replace thermal paint with etched surface treatment on thermal shields.	-24.0	-24.0	-150.0
520B-1	Landing Velocity envelope reduction to: 10-7-4 Design.		-26.6	-56.7
540B-2	Eliminate Delta V indicator.	- 1.8		- 7.5
INCORPORATED SWIP CHANGES - Total Weight		-261.9	-260.9	-1680.5

APPENDIX BWEIGHT IMPACTCRITICAL DESIGN REVIEW (CDR) 1 - PARTS 1 AND 2

The weight impact generated by Request For Changes (RFC) submitted during CDR 1 - Parts 1 and 2 has been re-evaluated. The data is self explanatory and is presented in tabular form.

Tables B-1 through B-4 summarize the weight impact by vehicle effectivity.

Tables B-5 through B-16 reflect the weight impact by sub-system responsibility and indicate the sub-systems effected. RFC effectivities and weight changes incorporated in ISR-490-33 are also indicated. RFC's not yet resolved or still in a study phase which could have an impact on hardware are listed as to be determined (TBD). These items will be monitored and reported on in subsequent reports.

The basis for deriving the weight estimates and a listing of references is provided in Table B-17.

The publication of the data, findings or conclusions contained herein, does not necessarily constitute the final weight impact resulting from CDR changes.

APPENDIX B - Cont.

WEIGHT IMPACT

CRITICAL DESIGN REVIEW (CDR) 1 - PARTS 1 AND 2

The weight estimates are predicated on the Grumman approach as to RFC resolution. Until NASA approval or concurrence is received on all items, this information is considered preliminary in nature and is presented for trending purposes only. It should not be construed to be contractually binding or final.

TABLE B-1

LEM 1  
RFC WEIGHT IMPACT SUMMARY  
CRITICAL DESIGN REVIEW 1-PARTS 1 AND 2

SUB-SYSTEM RESPONSIBILITY	TOTALS (INERT)		SUB-SYSTEMS EFFECTED																				
	ASC.	DEC.	STRUCT.	LDG. GEAR	EED	GN & C		PROPUL.		RCS		CREW PROM		ECS		INST.		EFS		COMMUN.		C & D	
						ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.		ASC.
<b>WEIGHT IMPACT</b>	(+3.0)	+17.0	(0)	(+99)	(-)	(-)	(0)	(0)	(+0.1)	(0)	(+4.4)	(0)	(0)					(+2.5)	(+2.6)			(+0.5)	(0)
INCORPORATED LSR-490-33	0	+4.5	0	0	-	-	0	0	+0.1	0	+4.4	0	0					0	0			0	0
NOT INCORPORATED	+3.0	+12.5	0	+9.9	-	-	0	0	0	0	0	0	0					+2.5	+2.6			+0.5	0
STRUCTURE	0	+2.9	0	+9.9																			
LANDING GEAR	-	-		-	-																		
ELECTRO-EXPLOSIVE DEVICES	0	0						0	0														
GUIDANCE NAVIGATION AND CONTROL	+0.7	+0.1						0	+0.1														
PROPULSION	+1.3	+7.0						0	+4.4														+0.5
REACTION CONTROL	+1.0	0											0	0									+1.0
<b>WEIGHT IMPACT</b>	(+2.1)	(0)																					(0)
INCORPORATED LSR-490-33	2.1	0																					
NOT INCORPORATED	0	0																					
CREW PROVISIONS	0	0																					
ENVIRONMENTAL CONTROL	+0.2	0																					
INSTRUMENTATION	0	0																					
ELECTRICAL POWER	0	0																					
COMMUNICATIONS	0	0																					
CONTROLS AND DISPLAYS	+1.9	0																					+1.8

TABLE B-2  
LEM 2

RPC WEIGHT IMPACT SUMMARY  
CRITICAL DESIGN REVIEW 1-PARTS 1 AND 2

SUB-SYSTEM RESPONSIBILITY	TOTALS (INERT)		SUB-SYSTEMS EFFECTED																		
	ASC.	DEC.	STRUCT.	LDG. GEAR	EED	GN & C	PROPUL.	RGS	CREW PROM		ECS		INST.		EFS		COMMUN.		C & D		
									ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.		ASC.	DEC.
WEIGHT IMPACT	(+ 4.0)	+18.4	(+0.3)	+9.9	(-)	(-)	(+0.1)	(0)	(+4.9)	(0)	(0)	(+0.5)	(+2.7)	+3.2	(+0.5)	(0)	(+0.5)	(0)	(+0.5)	(0)	
INCORPORATED LSR-490-33	0	+4.5	0	0	-	-	+0.1	0	+4.4	0	0	0	0	0	0	0	0	0	0	0	
NOT INCORPORATED	+ 4.0	+14.1	+0.3	+9.9	-	-	0	0	+0.5	0	0	+0.5	+2.7	+3.2	+0.5	0	+0.5	0	+0.5	0	
STRUCTURE	+ 0.3	+9.9	+0.3	+9.9																	
LANDING GEAR	-	-	-	-	-	-															
ELECTRO-EXPLOSIVE DEVICES	0	0																			
GUIDANCE NAVIGATION AND CONTROL	+ 0.7	+0.1				0	+0.1										+0.7	0			
PROVISION	+ 2.0	+8.6					0	+4.9									+0.5	+0.5	+1.0	+3.2	
REACTION CONTROL	+ 1.0	0						0	0								+1.0	0			
WEIGHT IMPACT	(+ 2.1)	(0)															(+0.2)	(0)	(+0.1)	(0)	
INCORPORATED LSR-490-33	2.1	0															+0.2	0	+0.1	0	
NOT INCORPORATED	0	0															0	0	0	0	
CREW PROVISIONS	0	0															0	0			
ENVIRONMENTAL CONTROL	+ 0.2	0															+0.2	0	0	0	
INSTRUMENTATION	0	0															0	0	0	0	
ELECTRICAL POWER	0	0															0	0	0	0	
COMMUNICATIONS	0	0																		0	
CONTROLS AND DISPLAYS	+1.9	0															+0.1	0			
																					+1.8

SUB-SYSTEM RESPONSIBILITY		TOTALS (INERT)		SUB-SYSTEMS EFFECTED																C & D							
				STRUCT.		LDG. GEAR		EED		GN & C		PROPUL.		RCS		CREW PROV.		ECS		INST.		EFS		COMMON.			
		ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.
WEIGHT IMPACT PART 1		(+14.5)	(+9.1)	(+1.3)	(+9.9)	(-)	(-)	(+9.5)	(-9.5)	(0)	(+0.1)	(0)	(+4.9)	(0)	(0)	(0)	(0)	(0)	(0)	(+0.5)	(+0.5)	(+2.7)	(+3.2)	(+0.5)	(0)	(+0.5)	(0)
INCORPORATED LSR-490-33		0	+4.5	0	0	-	-	0	0	0	+0.1	0	+4.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOT INCORPORATED		+14.5	+4.6	+1.3	+9.9	-	-	+9.5	-9.5	0	0	+0.5	0	0	0	0	0	0	0	+0.5	+0.5	+2.7	+3.2	+0.5	0	+0.5	0
STRUCTURE		+0.3	+9.9	+0.3	+9.9																						
LANDING GEAR		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ELECTRO-EXPLOSIVE DEVICES		+10.5	-9.5	+1.0	0			+9.5	-9.5		0	+0.1															
GUIDANCE NAVIGATION AND CONTROL		+0.7	+0.1																								
PROPULSION		+2.0	+8.6									0	+4.9								+0.5	+0.5	+1.0	+3.2	+0.5	0	
REACTION CONTROL		+1.0	0																								
WEIGHT IMPACT PART 2		(+9.3)	(+1.0)																	(0)	(0)	(+3.4)	(0)	(0)	(0)	(+3.7)	(0)
INCORPORATED LSR-490-33		+2.1	-1.6																	0	0	+0.2	+1.6	+0.1	0	0	+1.8
NOT INCORPORATED		+7.2	0																	0	0	-0.1	0	+2.0	0	+3.4	0
CREW PROVISIONS		0	0																	0	0						
ENVIRONMENTAL CONTROL		+0.1	+1.6																								
INSTRUMENTATION		+4.0	0																								+0.8
ELECTRICAL POWER		+0.3	0																								-0.1
COMMUNICATIONS		0	0																								0
CONTROLS AND DISPLAYS		+4.9	0																								+3.0

TABLE B-4

LEM 1 & SUB.  
RFC WEIGHT IMPACT SUMMARY  
CRITICAL DESIGN REVIEW 1-PARTS 1 AND 2

SUB-SYSTEMS EFFECTED

SUB-SYSTEM RESPONSIBILITY	TOTALS (INERT)		SUB-SYSTEMS EFFECTED																	
	ASC.	DEC.	STRUCT.	LDC. GEAR	EED	GN & C	PROPUL.	RCS	CREM PROV		ECS		INST.		EPS		COMMR.		C & D	
									ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.	ASC.	DEC.		ASC.
<b>WEIGHT IMPACT</b>																				
INCORPORATED LSR-490-33	+14.2	+4.6	+1.3	+9.9	-	+0.1	(-)	(-9.9)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
NOT INCORPORATED	0	+4.5	0	0	-	+0.1	0	+4.4	0	0	0	0	0	0	0	0	0	0	0	0
<b>TOTALS</b>	+14.2	+4.6	+1.3	+9.9	-	+0.1	(-9.9)	+4.4	0	0	0	0	0	0	0	0	0	0	0	0
<b>STRUCTURE</b>	+0.3	+9.9	+0.3	+9.9																
LANDING GEAR	-	-	-	-																
ELECTRO-EXPLOSIVE SERVICES	+10.5	-9.5	+1.0	0				+9.5	-9.5											
GUIDANCE NAVIGATION AND CONTROL	+0.4	+0.1																		
PROPULSION	+2.0	+8.6																		
REACTION CONTROL	+1.0	0																		
<b>WEIGHT IMPACT</b>																				
INCORPORATED LSR-490-33	+13.1	+4.1																		
NOT INCORPORATED	+1.8	+1.6																		
<b>TOTALS</b>	+11.3	+2.5																		
<b>CREM PROVISIONS</b>	+1.5	+1.0																		
ENVIRONMENTAL CONTROL	+0.7	+1.6																		
INSTRUMENTATION	+3.6	0																		
ELECTRICAL POWER	+0.3	0																		
COMMUNICATIONS	0	0																		
CONTROLS AND DISPLAYS	+7.0	+1.5																		

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 1  
 SUB-SYSTEM: STRUCTURE

TABLE B-5

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED								
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 1-10	STRUCTURE		Asc.		Dec.				
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.			
A-1	Protect Fuel & Ox Tanks With Hard Metallic Shield	0	+8.90		X		0	+8.90							
A-2	Nickel Foil Material For Meteoroid Bumper	0	+1.00		X		0	+1.00							
A-5	Alignment Aids For Docking Drogue Fittings	+30	0		2-10		+30	0							
Totals:		(0)	(+9.90)				(0)	(+9.90)							
LEM 1 & Sub.		0	0				0	0							
Incorporated		0	+9.90				0	+9.90							
Not Incorporated		(+30)	(+9.90)				(+30)	(+9.90)							
LEM 2 & Sub.		0	0				0	0							
Incorporated		+30	+9.90				+30	+9.90							
Not Incorporated															

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 1  
 SUB-SYSTEM: LANDING GEAR

TABLE B-6

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED													
		Asc.	Dec.	LEM	LEM	LEM	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.								
													1,2,3	1-10	4-10	Asc.	Dec.	Asc.	Dec.	
B-1,5	Touchdown Logic	TBD	TBD																	

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 1  
 SUB-SYSTEM: ELECTRO-EXPLOSIVE DEVICES

TABLE B-7

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED									
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 1-10	EED		STRUCTURE		Asc.	Dec.	Asc.	Dec.		
							Asc.	Dec.	Asc.	Dec.						
C-1	Provide APS Press After Staging	+10.50	-9.50		3-10		+9.50	-9.50	+1.00	0						
Totals:		(+10.50)	(-9.50)				(+9.50)	(-9.50)	(+1.00)	(0)						
LEM 3 & Sub. Incorporated		0	0				0	0	0	0						
Not Incorporated		+10.50	-9.50				+9.50	-9.50	+1.00	0						

RFC WEIGHT IMPACT															
CRITICAL DESIGN REVIEW 1 PART 1															
SUB-SYSTEM: GUIDANCE NAVIGATION & CONTROL															
RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED								
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 4-10	EPS		GN&C		Asc.	Dec.	Asc.	Dec.	
F-1, 81	Single Pulse Mode For S & C	+ .38	0		X										
F-54	DECA Power Supply Failures		+ .10		X							0		+ .10*	
F-73	Provide AGS Switching In LMP	+ .32	0	X											
	Totals: <u>LEMS 1, 2 &amp; 3</u> Incorporated Not Incorporated <u>LEMS 4 &amp; Sub.</u> Incorporated Not Incorporated	(+ .70) 0 + .70 (+ .38) 0 + .38	(+ .10) + .10 0 (+ .10) + .10 0						(+ .70) 0 + .70 (+ .38) 0 + .38	(0) 0 0 (0) 0 0				(+ .10) + .10 0 (+ .10) + .10 0	

\* Incorporated into IBM

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 1  
 TABLE B-9  
 SUB-SYSTEM: PROPULSION

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED								
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 4-10	PROP.		INST.		EPS		D & C		
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.	
D-2, 3, 5	Redundant Sensors; GAEC to Define Minimum Impact Implementation & Submit SCN	+0.70	+1.60		2-10		0	+0.50	+0.50	+0.50	+0.20	+0.60			
D-27	Post Landing Venting of Descent Tanks	+1.30	+7.00		X		0	+4.40*			+0.80	+2.60	+0.50		0
Totals:		(+1.30)	(+7.00)				(0)	(+4.40)			+0.80	(+2.60)	(+0.50)		(0)
LEM 1 & Sub. Incorporated		0	+4.40				0	+4.40			0	0	0		0
Not Incorporated		+1.30	+2.60				0	0			+0.80	+2.60	+0.50		0
LEM 2 & Sub. Incorporated		(+2.00)	(+8.60)				(0)	(+4.90)	(+0.50)	(+0.50)	(+1.00)	(+3.20)	(+0.50)		(0)
Not Incorporated		0	+4.40				0	+4.40	0	0	0	0	0		0
Totals:		+2.00	+4.20				0	+0.50	+0.50	+1.00	+3.20	+0.50			0

\* Incorporated in IBM

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 1  
 TABLE B-10  
 SUB-SYSTEM: REACTION CONTROL

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED										
		Asc.	Dec.	LEM 1-23	LEM 1-10	LEM 4-10	EPS		Dec.		Asc.		Dec.				
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.					
E-11	Modify Wiring To Allow Individual Valve Signatures	+1.00	0		X		+1.00	0									
Totals:		(+1.00)	(0)				(+1.00)	(0)									
LEM 1 & Sub.		0	0				0	0									
Not Incorporated		+1.00	0				+1.00	0									

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 2  
 TABLE B-11  
 SUB-SYSTEM: CREW PROVISIONS

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED									
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 4-10	Crew Prov.		Asc.		Dec.					
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.				
L-1	Net Debris Traps	TBD	TBD													
L-2	Smooth Projecting Edges	TBD	TBD													
L-3	Velcro Hooks	+ .50	0			X			+ .50	0						
L-6	Astronaut Docking Constraints "Unacceptable"	+ .50	0			X			+ .50	0						
L-7	Hatch Latch	+ .50	0			X			+ .50	0						
L-10	Platform Corrignations	0	+ 1.00			X			0	+ 1.00						
<u>Totals:</u>		(+1.50)	(+1.00)						(+1.50)	(+1.00)						
LEM 4 & Sub.		0	0						0	0						
Not Incorporated		+1.50	+1.00						+1.50	+1.00						

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 2  
 TABLE B-12  
 SUB-SYSTEM: ENVIRONMENTAL CONTROL

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED										
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 1-10	ECS		EPS		INST.						
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.					
N-3	Remove Delay Circuit	- .10	0		3-10		- .10	0									
N-8	Provide Interlock for L10H Cannister Selector	+ .10	0			X	+ .10*	0									
N-9	Delete GFE Item 421 and Provide a GAEC Support Clamp	+ .05	0			X	+ .05*	0									
N-10	Delete GFE Item 317 & Provide a Support Clamp	+ .10	0			X	+ .10*	0									
N-11	PLSS H <sub>2</sub> O Increase	0	+1.60			X	0	+1.60*									
N-13	Cabin Dump Valve Interlock	+ .05	0				+ .05*										
N-17	O <sub>2</sub> Sensor Redundancy	+ .50											+ .10	0	+ .40	0	
Totals:		+ .15	(0)				(+ .15)	(0)									
LEM 1 & 2		+ .15	0				+ .15	0									
Not Incorporated		0	0				0	0									
LEM 3		+ .05	(+1.60)				(+ .05)	(+1.60)									
Not Incorporated		+ .15	+1.60				+ .15	+1.60									
Not Incorporated		- .10	0				- .10	0									
LEM 4 & Sub.		+ .70	(+1.60)				(+ .20)	(+1.60)							(+ .40)	(0)	
Not Incorporated		+ .30	+1.60				+ .30	+1.60							0	0	
Not Incorporated		+ .40	0				- .10	0							+ .10	+ .40	0

\* Incorporated in IBM

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW I PART 2  
 SUB-SYSTEM: INSTRUMENTATION  
 TABLE B-13

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED									
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 4-10	INST.		EPS		C&D		CREW PROV.			
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.
I-3	Reduce Number Of Locking Knobs For Film and Tape Containers	- .40	0			X									- .40*	0
I-16	Real Time Ground Monitoring Of Individual RCS Thruster Fail	+3.00	0		3-10		+2.00	0	+1.00	0						
I-18	Monitoring Of EED	+1.00	0		3-10				+ .20	0	+ .80	0				
	<u>Totals:</u>	(+4.00)	(0)				(+2.00)	(0)	(+1.20)	(0)	(+.80)	(0)			(-.40)	(0)
	<u>LEM 3</u>	0	0				0	0	0	0	0	0			0	0
	Incorporated	(+4.00)	0				+2.00	0	+1.20	0	+ .80	0			(-.40)	(0)
	Not Incorporated	(+3.60)	(0)				(+2.00)	(0)	(+1.20)	(0)	(+.80)	(0)			0	0
	<u>LEM 4 &amp; Sub.</u>	- .40	0				0	0	0	0	0	0			- .40	0
	Incorporated	+4.00	0				+2.00	0	+1.20	0	+ .80	0			0	0
	Not Incorporated															

\*Incorporated into IBM

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW I PART 2  
 SUB-SYSTEM: ELECTRICAL POWER

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED								
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 1-10	EPS		D&C		Asc.	Dec.	Asc.	Dec.	
							Asc.	Dec.	Asc.	Dec.					
J-3, 6	DC Load Crew Safety Redundancy Review	TBD	TBD												
J-5	Auto Transfer of Power in Event of Feeder Fault	-0.10	0		3-10		0	-0.10	0						
J-11	AC Load Safety Redundant AC Bus	+0.40	0		3-10		+0.40	0	0						
Totals:		(+0.30)	(0)				(+0.40)	(0)	(-0.10)	(0)					
LEM 3 & Sub.		0	0				0	0	0						
Incorporated		+0.30	0				+0.40	0	-0.10	0					
Not Incorporated															

RFC WEIGHT IMPACT CRITICAL DESIGN REVIEW 1 PART 2 SUB-SYSTEM: COMMUNICATIONS																					
RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED														
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 4-10	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.									
NONE																					

FORM G328 REV 1 8-64

QR 1700 Contract No. NAS 9-1100

Primary No. 713 GRUMMAN AIRCRAFT ENGINEERING CORPORATION

REPORT LSR-490-33

DATE 1 June 1966

CODE 26512

RFC WEIGHT IMPACT  
 CRITICAL DESIGN REVIEW 1 PART 2  
 SUB-SYSTEM: CONTROLS AND DISPLAYS  
 TABLE B-16

RFC No.	DESCRIPTION	WEIGHT IMPACT		EFFECTIVITY			SUB-SYSTEMS EFFECTED											
		Asc.	Dec.	LEM 1,2,3	LEM 1-10	LEM 1-10	C & D		CREW PROV.		INST.		EPS					
							Asc.	Dec.	Asc.	Dec.	Asc.	Dec.	Asc.	Dec.				
M-2	Indicate Loss Of Power/Sig-nal to Meters	+1.80	0		X			+1.80*	0									
M-10	Restore Rheostat on Backup Flood Lights	+2.10	+1.50			X		+2.10	+1.50									
M-19	Crew Station Provisions For Flight Data Kit	TBD	TBD							TBD	TBD							
M-23	S-Band Receiver C & W Tone for Lunar Stay Sleep	+ .10	0		X								+ .10*	0				
M-24	RCS Heater Control	+3.00	0		3-10			+1.20	0							+1.80	0	
	Totals:	(+1.90)	(0)					(+1.80)	(0)							(+1.80)	(0)	
	LEM 1 & 2	+1.90	0					+1.80	0							+ .10	0	
	Not Incorporated	0	0					0	0							0	0	
	LEM 3	(+4.90)	(0)					(+3.00)	(0)							(+1.10)	(0)	
	Incorporated	+1.90	0					+1.80	0							+1.10	0	
	Not Incorporated	+3.00	0					+1.20	0							0	0	
	LEM 4 & Sub.	(+7.00)	(+1.50)					(+5.10)	(+1.50)							(+1.10)	(0)	
	Incorporated	+1.90	0					+1.80	0							+1.10	0	
	Not Incorporated	+5.10	+1.50					+3.30	+1.50							0	0	

\*Incorporated in IHM

TABLE B-17

<u>RFC No.</u>	<u>Basis for Weight Estimate</u>	<u>Reference</u>
A-1	Quad. 2 will have a partial (.004) aluminum shield, quad 3 lower deck to be (.004) aluminum or (.00125) inconel foil, prop. tank shield to be .016 aluminum chem milled to .004. (+8.9#)	LDW280-23700
A-2	Inconel (.0005) to be used for two forward quadrants, inconel (.00125) to be used for the two aft quadrants. (+1.0#)	LDW280-28666
A-5	Modified drogue fittings to aid docking alignment. (+0.3#)	LDW280-M10840 LDW280-M10844 LDW280-M10960
B-1,5	Still TBD, pending NASA reply.	LLR-470-31
C-1	Transfer pyro battery and pyro relay box from descent stage to the ascent stage. Add support structure (+1.0#)	LTX-540-300 LLR-150-1249 LLR-250-67 PCCP 145
D-2,3,5	Added 1 Propulsion transducer and 2 Instrumentation transducers (+1.5#) and 550 ft., H-FILM wire, AWG 26. (+0.8#)	LLR-360-93
D-27	Added 2 squib valves (+1.00#), 2 solenoid latching valves (+2.76#) 2 test couplings (+0.44#), misc. plumbing (+0.15#), 2 switches (+0.5#), electrical components and wire. (+3.40#)	SCN 73
E-11	Added 700 ft. of H-FILM wire, AWG. 26. (+1.0#)	LDW-310-53000
F-1,81	Added 7, 16 ft., twisted, shielded AWG. 26 wires. (+0.38#)	LTX-370-02
F-54	Added electronic components (+0.1#)	LVC 300-13-035
F-73	Added 2 twisted pairs and 1 twisted triplet, 15 ft., AWG 22, H-FILM. (+0.32#)	LMO-304-14 LAV-304-130

TABLE B-17 -Cont.

<u>RFC No.</u>	<u>Basis for Weight Estimate</u>	<u>Reference</u>
I-3	Removed 4 Backing-Locking knobs from film and tape containers. (-0.4#)	LDW340-23325
I-16	Increase to Signal Conditioner Electronic Assy. (+1.0#), 700 ft. of AWG. 26 H-FILM wire (+1.0#), and structural mounting supports. (+1.0#)	LTX-360-66 LTE-500-132 LTE-250-101
I-18	Added pyro caution light (+0.2#), Component status lights (+0.4#), increase to Caution and Warning Electronic Assy. (+0.2#) and added 140 ft. of AWG. 26, H-FILM wire (+0.2#)	LLR-250-67
J-3,6	Weight impact is still TBD. Reliability is performing a single point failure study to define problem areas.	LTX 390-39
J-5	Deleted Switch 4 S16. (-0.10#)	LTX 390-44
J-11	Added two circuit breakers (+0.2#) and 54 ft., AWG. 22, H-FILM wire. (+0.2#)	LLR 390-91 LTX 390-41
L-1	Still TBD. Information will not be available till 6/15/66.	LLR-340-96
L-2	Still TBD. Some redesign is indicated.	LLR-340-94
L-3	Added additional Velcro hooks (+0.5#)	LLR-340-93
L-6	Redesigned harness fittings (+0.5#)	LLR-340-95
L-7	Added mechanical hatch latch (downstop) in lieu of Velcro (+0.5#)	LDW-280-23335 LDW-280-10319
L-10	Changed corrugation spacing and density of foam on Egress platform (+1.0#)	LLR-340-91
M-2	Positive indication feature added 0.09 lbs. per meter. There are 20 meters. (+1.8#)	LLR-350-10 LTE-540-167 LTX-250-24
M-10	Added 2 rheostats (+0.5#), 70 ft. of AWG. 26, H-FILM wire (+0.1#), and water. (+3.0#)	LTX-390-43 LMO-390-774

TABLE B-17 -Cont.

<u>RFC No.</u>	<u>Basis for Weight Estimate</u>	<u>Reference</u>
M-19	Weight impact is still TBD. Addition of a writing board would cause a weight increase.	LTX-340-41 LTX-340-44
M-23	Increase to Caution and Warning Electronic Assembly. (+0.1#)	LTX-360-69 LVC 364-008-044
M-24	Added 4 3- pole switches (+1.2#), connectors and cable (+1.8#).	LAV-540-408 LLR-540-320
N-3	Deleted electrical components. (-0.1#)	LVC 331-002-107
N-8	Added mechanical guard. (+0.1#)	LDW 330-10018-1
N-9	Added a teflon hose clamp. (+0.05#)	LVC-331-002-109
N-10	Added a teflon hose clamp and bracket. (+0.1#)	LVC-331-002-103
N-11	Additional water required. (+1.6#)	
N-13	Added mechanical guard. (+0.5#)	LDW 330-54011-1
N-17	Added pressure transducer (+0.4#) and 70 ft. of AWG. 26, H-FILM wire (+0.1#).	CCA 239